# NOTE ON THE OCCURRENCE OF DIATOMS, RADIOLARIA AND INFUSORIA IN THE ROLLING DOWNS FORMATION (LOWER CRETACEOUS), QUEENSLAND.

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(Plates xvii.-xix.)

## i.—Introductory.

This note is intended to be preliminary to a fuller description which we hope to furnish later when a larger supply of the material is available.

Some years ago, by the courtesy of Mr. R. L. Jack, the late Govt. Geologist of Queensland, one of the authors was allowed to take a chip of limestone from a specimen in the Geol. Survey Museum, Brisbane, with a view to examine it for Radiolaria. The specimen came from the Maranoa River, Queensland, from a bed of limestone interstratified in the Lower Cretaceous (Rolling Downs) Formation. This particular piece of limestone was selected for special examination because its surface had weathered into a soft brown crust like Bath brick, closely resembling in this respect the Middle Devonian radiolarian limestones of Tamworth, N.S. Wales. An examination for radiolaria of thin sections of this rock under an inch objective proved disappointing, and the sections were put aside, but on being re-examined about two months ago with a $\frac{1}{4}$ inch objective with a view to studying the nature of the network of a fragmental radiolarian shell, it was observed that numerous black particles, which under the lower power appeared structureless, now showed definite structure.

Subsequent examination convinced us that many of these forms were Diatoms, and some probably Infusoria.

(*a*) *Diatoms.*—Diatoms in rocks older than the Tertiary being of comparatively rare occurrence, the literature on the subject is not extensive, so that a short reference to the principal papers may be given here.

Summarising what is at present known about the fossil Diatomaceæ, Seward* says :—"With the exception of two species of Liassic Diatoms, no trustworthy examples of the *Diatomaceæ* have been found below the Cretaceous Series. The oldest known Diatoms were discovered by Rothpletz† among the fibres of an Upper Lias Sponge from Boll in Württemberg. . . . Rothpletz describes two species which he includes in the genus *Pyxidicula*, *P. bollensis* and *P. liassica.*"

The siliceous frustules referred to these species occur in great numbers, associated with coccoliths, among the horny fibres of the fossil sponge *Phymatoderma.* The frustules are thimble-shaped, minutely punctate or perforate (apparently the latter to judge from the figures), and measure in greatest diameter 6-14 $\mu$. They are usually isolated, but very rarely are met with in pairs united at their open ends, the two portions in this case being of unequal size. They do not, however, overlap one another, neither is any girdle present.

Rothpletz compares these forms with the genus *Stephanopyxis* (Schütt) and the sub-genus *Pyxidicula* (Schütt). The former possesses spines on both valves, while the latter is devoid of spines. Rothpletz figures (*op. cit.*, p. 911) a form of *Stephanopyxis* from the Oligocene marl of Thisted in Denmark. Many Cretaceous Diatoms have been figured by Ehrenberg‡ from the

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* Seward, Fossil Plants, Vol. i., p. 154.

† Rothpletz, Ueber die Flysch-Fucoiden und einige andere fossilen Algen sowie über liasische Diatomeen führende Hornschwamme. *Zeits. Deutsch. Geol. Gesell.*, 1896, xlv., pp. 854-914. Also, Nachtrag zu meinem Aufsatz über einen neuen Jurassischen Hornschwamme und die darin eingeschlossenen Diatomeen. *Op. cit.*, 1900, lii., pp. 388-389.

‡ Ehrenberg (C. G.), Mikrogeologie. Leipzig, 1854. Und Forsetzung. Idem, 1856.

Austrian deposits. He remarks that the Tertiary and Cretaceous Diatoms show a very marked resemblance to living forms.

Unfortunately we have not at present access to most of Ehrenberg's works.

Cayeux* has also recorded the occurrence of Cretaceous Diatoms in France. In these deposits the skeleton is replaced by carbonate of lime.

These Diatoms are referred chiefly to *Triceratium*.

Rüst† has figured a *Coscinodiscus* from the coprolites of the Jurassic strata of Ilsede in Hanover, and from the same rocks several species of the infusorian *Tintinnus*.

Count Castracane‡ has described what he considers to be Diatoms from the Carboniferous rocks of France, England and Scotland.

The origin, however, of these diatoms is questioned by many palæobotanists, the general opinion being that they are adventitious rather than *in situ*.

(*b*) *Radiolaria*.—As regards radiolaria, the remains of these exclusively marine micro-organisms have been found in sedimentary rocks of almost all ages, and Cretaceous forms have been

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* Cayeux (L.), Contribution à l' étude des Terrains Sédimentaires. *Mém. Soc. Géol. Nord*.iv., 2. See specially pp. 61, 375, 458.

He says, *op. cit.*, p. 458, "Celles [Diatomées] que j'ai observées sont indépendantes des silex J'en ai trouvé dans la craie à *I.* [*Inoceramus*] *labiatus* de la vallée du Cher et dans la craie à *M. breviporus* du Bray. Elles sont extrêmement rares de part et d' autre. La determination n'en est pas encore faite. J'en ai également s ignalé la présence dans le Campanien silicieux du S. O. du Bassin."

Also, "Sur la présence de nombreuses Diatomées dans les gaizes jurassiques et crétacées du Bassin de Paris. De l' existence de Radiolaires dans les gaizes crétacées de ce même Bassin." *Ann. Soc. Géol. Nord*. xx., 1892, pp. 57-60.

† Rüst, Beiträge zur Kenntniss der fossilen Radiolarien aus Gesteinen des Jura. Palaeontographica, xxxi., pl. xliv. (xix.), p. 320.

‡ Comptes rendus Acad. Sci., Paris, 1874, lxxix,, p. 52.

described by Hinde,* Rüst,† Cayeux,‡ and others. A general summary of the more recent literature relating to fossil radiolaria is given by one of us in papers read before this Society in 1896.§

It will not be out of place to casually refer to the great series of radiolarian-bearing rocks of Devonian age occurring at Tamworth, the micro-fauna of which has been so thoroughly investigated by Dr. Hinde.

As regards radiolarian rocks in Australia which may belong to the same geological system as those of the Maranoa River, Queensland, the fact may be mentioned that the rock from Fanny Bay, Port Darwin, is considered to be very probably of Upper Cretaceous (Desert Sandstone) age, and Dr. Hinde, in describing it, says:—"The rock in question is of a dull white or yellowish-white tint, in places stained reddish with ferruginous material; it has an earthy aspect, like that of our Lower White Chalk, though it can be scratched by the thumb-nail." Tenison-Woods, in his "Report on the Geology and Mineralogy of the Northern Territory," described the cliffs as being capped by beds of compact white or yellowish-white rock, for the most part magnesite. Dr. Hinde, in speaking of the mode of occurrence of the rock, says:—"Mr. Bassett-Smith states that the white radiolarian rock forms a very prominent feature in the steep cliffs, from 30 to 50 feet in height, which border the harbour of Port Darwin. The rock is exposed for many miles on the Fanny Bay side of the harbour, and extends continuously from point to point across the bay. A section in the cliff at Fanny Bay consists at the base of mica-schist

* Note on a Radiolarian Rock from Fanny Bay, Port Darwin, Australia. *Quart. Journ. Geol. Soc.*, 1893, xlix., pp. 221-226, pl. 5.

† Palaeontographica, 1885, xxxi., pp. 269-322; 1888, xxxiv., pp. 181-213; 1892, xxxviii.

‡ Contribution à l'étude micrographique des Terrains Sédimentaires. *Mém. Soc. Géol. Nord.*, 1897, pp. 185-206, pls. 7, 8.

§ David (T. W. E.), The Occurrence of Radiolaria in Palæozoic Rocks in N.S. Wales. *P.L.S.N.S.W.*, xxi., pp. 553-570, pls. 37, 38. David and Howchin, Note on the Occurrence of Casts of Radiolaria in Pre-Cambrian (?) Rocks, South Australia. *Ibid.*, pp. 571-583, pls. 39, 40.

and quartz, on which discordantly rests a narrow band of soft ochre-like clay, followed above by the white radiolarian rock, which varies in places from 10 to 30 feet in thickness. It is covered by a layer of ironstone conglomerate, of a few feet in thickness, which caps the cliff. The white rock appears to be nearly horizontal; it contains, more particularly in the upper portion, numerous nodules, varying in size from that of a walnut to that of a cocoanut. In weathering it becomes soft and shows a great variety of tints, from pure white to deep red. No fossils can be found in it. It is used extensively for building purposes, and it is eaten by the natives, probably on account of its purgative properties. Mr. Bassett-Smith further states that the white radiolarian rock is unaffected by heated hydrochloric or nitric acid, and it is the same as that designated 'magnesite' in Tenison-Wood's report. It thus seems probable that this material, so widely distributed in the northern area of Australia, and reaching in places a thickness of 130 feet, may prove to be, as already suggested, a deep-sea deposit of radiolarian origin."

The forms described belong to the suborders Prunoidea, Discoidea, and Cyrtoidea, and comprise the following genera and species :—

PRUNOIDEA—*Cenellipsis.*

DISCOIDEA —*Astrophacus*, spp. *a. & b.*
*Lithocyclia exilis.*
*Amphibrachium crassum.*
,, *truncatum.*
,, *fragile.*
,, sp.
*Spongodiscus expansus.*
,, spp.
*Spongolena symmetrica.*

CYRTOIDEA—*Dictyomitra australis.*
,, *triangularis.*
*Lithocampe fusiformis.*
*Stichocapsa pinguis.*
,, *chrysalis.*

One noteworthy fact about these Port Darwin radiolaria is that no spine-bearing forms are preserved, a fact that apparently is to be noticed in the case of the Maranoa specimens also.

(*c*) *Infusoria.*—As far as we are aware fossil Infusoria have not been recorded previously from Australia.

Dr. Rüst (*op. cit.*), as already stated, has recorded their occurrence in the Jurassic rocks of Ilsede in Hanover.

### ii.—Mode of Occurrence.

In the months of October and November of the year 1885 Mr. (now Dr.) R. L. Jack made a journey through the southern part of the western interior in company with Mr. J. B. Henderson, the Hydraulic Engineer, with the object of fixing a site to bore for artesian water.

In the Maranoa River, about half-a-mile north of Mitchell, Dr. Jack found bands of a dark-coloured limestone in blue shales. This limestone occurs in the Rolling Downs Beds not far from their base.

In the "Geology and Palæontology of Queensland," by Jack and Etheridge, Dr. Jack describes these rocks briefly as follows:—"On the Maranoa River, about half-a-mile north of the railway, are blue shales with bands of limestone nodules. The shales and limestones at the lowest point down the river dip up the river at about 15 deg. The remainder of the section dips, if anything, up the river, but is practically horizontal. From the limestone nodules I obtained numerous fossils, among which my colleague recognised the Pelecypoda, of which a list is given on a subsequent page" (p. 404).

The fossils are as follows:—

Pelecypoda — *Maccoyella Barklyi*, Moore.
*Pseudavicula anomala*, Moore.
*Corbicella* (?) *maranoana*, Eth. fil.
*Glycimeris Tatei*, Eth. fil.
,, *rugosa*, Moore.
*Gastrochæna australis*, Eth. fil.

Gasteropoda—*Natica variabilis*, Moore.

Mr. R. Etheridge, junr., adds a footnote to the effect that in a collection from the Lake Eyre Basin, submitted to him by Prof. R. Tate, an exactly similar matrix and mode of preservation of the fossils exists.

A sketch section is attached showing the position of the limestone (Plate xvii.).

### iii.—Description of the Forms figured.

In a preliminary note like the present we have selected for figuring two forms which we believe to be Diatoms, one example of the Radiolaria, and one which we believe to be an Infusorian type, allied to, if not identical with, *Tintinnus*.

Nearly all the micro-organisms are preserved in the form of jet black material, with the exception of the Diatom (Pl. xviii., fig. 2). The latter is most frequently represented by a cast in clear calcite, but in several cases a black network can be seen enveloping the calcite.

As regards their mineral constitution, on treatment in dilute acetic acid it is found that the greater part of the netted forms disappear completely. Those which are left intact are mostly *Coscinodiscus*, or some allied type of Diatom. So far as our experiments went, no Radiolarian shells were noticed among the residues after treatment with acetic acid, which suggests either that the skeletons visible in the thin sections of the Maranoa limestones have been replaced by calcite, or that the skeleton was originally acanthinous. The fact that most of the black nets disappear after treatment with acetic acid, considered in conjunction with their shape and size, suggests that they are Infusorian loricæ, and that these organisms outnumbered the Diatoms and Radiolaria in the Maranoa limestones.

(*a*) *Diatoms.*—The form referred by us to the genus *Coscinodiscus* (Pl. xviii., fig. 1.) is disc-shaped and circular in outline.

Its diameter is 0·095 mm., and the diameter of the meshes varies from 0·00125 mm. to 0·0017 mm. The disc is slightly convex, the amount of departure from a plane surface at the centre of the disc being about from 0·0004 to 0·0005 mm. The openings

in the mesh-work appear to be sub-hexagonal, and the width of the dark bars of the mesh-work is only a little less than the diameter of the openings, viz., about 0·001 mm.

There are from 33 to 34 meshes to the full diameter of the disc.

In the figure the frustule is magnified ( × 350 diameters).

Diatom genus (?).—The sections of which a photograph and drawing are shown on Pl. xviii., fig. 2, and Pl. xix., fig. 1, were originally mistaken by us for a naviculoid type of diatom; we were inclined at first to refer it to *Nitzschia*, then to *Amphora*. Later it was noticed that in some of the sections a distinct delicate hexagonal mesh-work was visible on one or both sides. The mesh-work appears to be more distinctly hexagonal than that of *Coscinodiscus*, and the bars of the network seem to be of about the same diameter as those of the latter type. The diameter of the openings in the mesh-work varies from about 0·003 to 0·0036 mm. ; and the diameter of the bars of the mesh-work is about 0·001 mm. The girdle (?) view of this form shows that the hexagonal netting extends completely across the ends, but it would appear that the mesh-work on the girdle (?) is rather smaller than that on the valve surfaces Hitherto, however, we have been unable to obtain accurate measurements of their size, neither have we been able to ascertain whether there is any trace of overlapping laminæ in what we take for the girdle zone. We believe that the sections illustrated on Pl xviii., fig. 2, and Pl. xix., fig. 1, are radial sections through a biconvex form becoming slightly biconcave towards the edges. The girdle (?) is a comparatively wide median zone measuring about 0·01 mm. in inside diameter, and 0·0175 mm. in outside diameter. A fact opposed to the view that the ends of the forms figured represent radial sections cut through the girdle, is that in many of the sections one end appears to be wider than the other. In such cases, however, it is doubtful whether the specimen is completely preserved so as to show the complete girdle face at each end. The extreme outer diameter, measured parallel to the long axis of the figure, is 0·1675 mm., and the extreme inner diameter is about 0·164 mm. The diameter of this form is,

therefore, nearly twice that of the *Coscinodiscus* figured by us. The greatest transverse outside diameter, measured at right angles to the long axis of the figure of the form shown on Pl. xix., fig. 1, is 0·025 mm., and the greatest internal measurement, in the same direction, is about 0·018 mm. There seems to be a distinct wall present inside the hexagonal network. This wall is about 0·003 mm. thick, and at first sight appears to be perforated, but it is doubtful whether it really is so. The thickness of the wall at the ends (the girdle [?]) is about 0·0016 mm.

As regards the mineral constitution of the comparatively thick wall, it is seen to be chiefly calcite, when examined in polarised light.

That the sections figured are diagonals of discs cut approximately at right angles to the valve surfaces of the disc, is rendered probable by the occasional occurrence of associated circular forms, which, in one case at least, agree in measurement exactly with the form figured (Pl. xviii., fig. 1). These circular forms also exhibit in some cases a hexagonal mesh-work. Blackish opaque spherical bodies are visible in most of the specimens of this type of Diatom (?). Some of these are figured on Pl. xix., fig. 1. They vary in diameter from about 0·005 to 0·01 mm.

(*b*) *Radiolaria.*—Complete shells are rare, but fragments of radiolarian skeletons are plentiful. One of the most complete forms observed is figured by us on Pl. xviii., fig. 3, and Pl. xix., fig. 3. It consists of three concentric shells, united by radiating cross-bars.

The extreme diameter of the cortical shell (outside measurement) is 0·11 mm. The extreme diameter of the middle shell (outer medullary test [?]) is 0·045 mm., and that of the inner medullary shell 0·0225 mm. This genus agrees fairly well in shape and size with the form figured by Dr. Hinde (*op. cit.*) from Port Darwin as *Astrophacus*.

(*c*) *Infusoria—Tintinnus* sp.—The form figured belongs to a type which is very abundant and characteristic in this rock. It resembles a syringe in shape. The lorica is formed of a delicate black hexagonal mesh-work. Its greatest length, as preserved,

is 0·0835 mm., and the width 0·007 mm. The diameter of the meshes is about 0·0015 mm.

This form resembles that figured by Rüst in "Palaeontographica," 1885 (Vol. xxxi., Pl. xliv. (xix.), fig. 1) from the Jurassic coprolites of Ilsede in Hanover, and the recent form figured by Saville Kent in his Manual of the Infusoria (1880-1882, Vol. iii., Pl. xxxi., figs. 18-19). This form is *Tintinnus denticulatus*, Ehr. Saville Kent states (*op. cit.*, Vol. ii., p. 607) that this form is salt water in its habit, and that it is found in the Baltic Sea and on the Norwegian coast, and that its distribution would appear to be general and abundant throughout the seas of Northern Europe. Kent, however, describes its lorica as having its "surface regularly shagreened with minute hexagonal facets," whereas in the Queensland Lower Cretaceous form the lorica consists of open hexagonal meshwork, resembling in this respect the form figured by Rüst.

A great variety of loricæ of infusoria are visible in this limestone, but for the present we defer figuring them until more of the material is available.

We beg to gratefully acknowledge the very valuable help that has been given us by Mr. L. C. Green of the Geological Survey of Queensland, who has bestowed much time and care in obtaining for us microphotographs of the organisms figured in the plates.

We also desire to thank Mr. T. Steel, F.L.S., for his kind loan to us of Adolf Schmidt's "Atlas der Diatomaceen-Kunde," and other works relating to Diatoms, and would express our obligations to Mr. J. P. Hill, B.Sc., for his loan to us of his collection of Diatoms, and to Prof. Haswell, F.R.S., for numerous references to works dealing with the Infusoria.

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## EXPLANATION OF PLATES.

### Plate xvii.

Section showing the Horizon of the Lower Cretaceous Limestone containing Diatoms, Radiolaria and Infusoria, from Maranoa River, Queensland. By W. H. Rands, F.G.S.

Plate xviii.

Fig. 1.—*Coscinodiscus* sp. Lower Cretaceous (Rolling Downs) Formation; Maranoa River, Queensland (× 350). Photo by L. C. Green.

Fig. 2.—*Diatom*, genus (?). Lower Cretaceous (Rolling Downs) Formation; Maranoa River, Queensland (× 350). Photo by L. C. Green.

Fig. 3.—Radiolarian shell consisting of three concentric shells, perhaps *Astrophacus*, from Lower Cretaceous (Rolling Downs) Formation; Maranoa River, Queensland (× 350). Photo by L. C. Green.

Plate xix.

Fig. 1.—*Diatom*, genus (?). Similar to above (× 350).

Fig. 2.—*Tintinnus* sp., from Lower Cretaceous (Rolling Downs) Formation; Maranoa River, Queensland (× 900).

Fig. 3.—Drawing of Radiolarian shell (Pl. xviii., fig. 3), showing details of structure.